an elevation of 50 feet. This species is almost identical with *Gammarus marinus*, from which it differs only in a clothing of hairs like that of other lacustrine species.

The second species belongs to the genus *Orchestia* (*O. cavimana*). It was found in great abundance by M. Kotschy in Cyprus, upon Mount Olympus, at an altitude of 4000 feet. It lives in moist places, in the vicinity of a spring. This species appears to differ from *O. Montagui* only by insignificant characters, such as a somewhat smaller size and a darker colour.—*Siebold & Kölliker's Zeitschrift*, xix. p. 156; *Bibl. Univ.* xxxv. June 15, 1869, *Bull. Sci.* pp. 158–160.

On the Leaves of Coniferæ.

By Thomas Meehan, of Germantown, Pennsylvania.

Botanists can scarcely have overlooked the fact that the true leaves of *Pinus* consist of bud-scales, and that what are known as leaves, and what Dr. Engelmann (Gray's Manual, 5th edition, p. 469) calls "secondary leaves" are but phylloid shoots; but I have failed to find any specific reference to the fact in botanical works. Dr. Dickson, however, in a paper "On the Phylloid Shoots of *Sciadopitys verticillata*" (Proceedings of Botanical Congress, 1866, p. 124), remarks, "In *Sciadopitys* I have to call attention to the fact that the leaves of the growing shoots consist, as in *Pinus*, entirely of bud-scales." One would suppose, from this incidental reference to *Pinus*, that he was acquainted with the fact that the so-called leaves of *Pinus* were phylloid shoots; but as the object of the paper is to show that the so-called leaves of *Sciadopitys* are not true leaves, and as any one must know that they are not if already cognizant of the fact in *Pinus*, we may take it for granted that at any rate, if not entirely overlooked, little thought has been given it. I believe I am occupying an entirely original field in pointing out the true nature of leaves in *Coniferæ*, and that the increased knowledge will have an important bearing on many obscure points in their study.

Dr. Dickson uses but the language of general botany when he describes the true leaves of *Pinus* as "bud-scales," meaning thereby the scaly free portion just under the "secondary leaves" of Engelmann, and sometimes forming sheaths around them. But these free scales are scarcely leaves. The chief portion of the true leaves in most plants of the order are adnate with the stem; sometimes they have the power to develope into scaly points, at others into foliaceous tips, and at other times are without any power but to preserve their true leaf-like character. *Larix* affords the best illustration. The true leaves are linear-spathulate, entirely adnate to the stem. There are two kinds of stem-growth in *Larix*: in the one case the axis elongates and forms shoots; in the other, axial development is arrested and spurs are formed. On the elongated shoots the leaves are scattered; on the spurs they are arranged in whorls. The power of elongation possessed by the shoot is imparted to the leaves which are adherent to it, and they produce green foliaceous awl-like tips; the power of elongation which the spurs have lost is also measurably lost to their leaves: they develope themselves fully, although they have no stem to adhere to; they preserve the spathulate form, but cannot produce the awl-shaped tips of the shoot-leaves. There are, therefore, two forms of leaves on the larch, the one free, the other adherent; and we have a novel principle very clearly illustrated, that *strong axial development* (vigour) *is a characteristic of adhesion, while the reverse* (weakness) *is characterized by a free system of foliation.* Any species of *Larix* will sustain this observation; and *leptolepis,* as a vigorous grower, is the best.

The characteristics of the foliage described in *Larix* may be found in a greater or less degree in a great many species of coniferous plants. In *Cryptomeria* the leaves adhere for four-fifths of their length on vigorous shoots; but on the more delicate ones they are free for three-fourths or more. In *Juniperus* the different forms of foliage are well known, especially in *J. virginiana, J. chinensis,* and *J. communis.* On the vigorous shoots adhesion takes place for nearly the full length of the leaves; but on weaker ones the leaves are very nearly free. In *Thuja, Biota, Retinispora, Cupressus, Thujopsis,* indeed most of the section *Cupressineæ,* these variable degrees of adhesion may be found, and always in relation to the absence or presence of vigour: and on this question of vigour it will be well here to make a few remarks. The power to branch I take to be a high mark of vigour. The young seedlings of most coniferous trees grow but a few inches the first year, and have no power to branch; the power increases with age, and in all cases in proportion to the vigour of the plants. In *Thuja,* for instance, no branches appear till the second year; they increase in number, until, when in its prime, branches appear from every alternate pair of axils, and, as these are decussate, this gives the fan-like form of growth of which the *Arbor vitæ* affords a familiar illustration.

This varying power of adhesion in the true leaves, and in connexion with vigour, enables us to explain many matters hitherto not understood. For instance, Dr. Lindley describes a form of *Biota* as *B. meldensis,* suggesting that from its appearance it must be a *hybrid between the red cedar and Chinese Arbor vitæ*; it is but *B. orientalis* with the leaves moderately united. *Thuja ericoides* of gardens was long supposed to be a Japanese species; it is but an entirely free-leaved form of *Thuja occidentalis. Retinispora ericoides* of Zuccarini is but a free-leaved form of some Japanese plant; and in all probability many species of *Retinispora,* so marked in herbariums, are all forms of one thing with more or less adnate leaves. In all these cases delicacy of growth and freedom of leaves go gradually together, as before indicated.

One of the most remarkable instances of the value of this principle, however, will, I have no doubt, be in fixing the identity of the Japenese genus *Glyptostrobus* * of Endlicher with the American *Taxodium* of Richard. In a shoot one foot in length of the latter we find perhaps four or six branchlets; in the same space in *Glyp-*

* *Note by the proof-reader.*—It was the intention of the author to refer his remarks on *Glyptostrobus* to *G. sinensis,* Endl.

tostrobus we shall find a score or more. Indeed in this plant a branchlet springs from nearly every axil on the main branch, showing an extraordinary vigour. As vigour is opposed to a free development of foliage, the small thread-like leaves of *Glyptostrobus* are naturally to be expected, and the free leaves distichously arranged is the natural concomitant of the weaker *Taxodium.* Fortunately I am able to sustain this theory by actual facts. I have a seedling tree ten years old, of remarkable vigour. It does not branch quite as much as the typical *Glyptostrobus*, but much more freely than any *Taxodium.* The result is, the foliage is aciculate, not distichous, and just intermediate between the two supposed genera. But to help me still more, my tree of *Glyptostrobus* has pushed forth some weak shoots with foliage identical in every respect with the intermediate *Taxodium.* Specimens of all these are presented with this. In establishing *Glyptostrobus,* Endlicher notes some trifling differences in the scales of the cones between it and *Taxodium*; but all familiar with numerous individuals of some species of Coniferæ, *Biota orientalis* for instance, know how these vary. There can be no doubt, I think, of the identity of the two; and this will form another very interesting link in the chain of evidence that the flora of Japan is closely allied to that of the United States.

If we were to look on the so-called leaves of *Pinus* and *Sciadopitys* as true leaves, we should find serious opposition to my theory that a vigorous axial growth is opposed to the development of free leaves in Coniferæ; for we should see a class of plants which notoriously adds but from three to six branches annually to each axis clothed with foliage. But admitting them to be phylloid shoots, it confirms our theory in a strong degree. We then see a plant loaded with branchlets; and so great is the tendency to use them instead of leaves, that in some cases, as in *Pinus strobus, P. excelsa,* and others of a softer class of Phylloideæ, the bud-scales are almost entirely confined to the sheathing leaflets—just as in the very rugged, hard-leaved, almost spinescent forms, like *Pinus austriaca,* we find them more dependent on well-developed adnate leaf-scales. In *Abies* of old authors, *A. excelsa* for instance, we have a numerous-branching tendency; hence we have true leaves, though partially adnate, and no necessity for phylloid branchlets. In *Picea* of Link, almost near *Abies*, taking *P. balsamea* as a type, we have a rather weaker development, slower-growing and less hardy trees, and the leaves are nearly free. Could some of the shoots of *Abies* be arrested in their axial development, as in *Larix*, we should have the remainder increased in length, and the fewer branchlets and two forms of leaves just as in *Larix.* Should, on the other hand, the plant increase in vigour, there would be no class of free leaves, adnation would be the law, and metamorphosed branchlets prevail. Starting from *Abies,* extra vigour makes the pine, extra delicacy the larch; it is the centre of two extremes.

That the fascicles in *Pinus* are phylloid shoots, I think cannot be questioned. Their position in the axils of the true leaves, as beautifully shown in *Pinus austriaca,* indicates the probability; their permanency in proportion to their induracy is also another strong point. The soft ones of the *Strobus* section retain vitality little longer than some true leaves, while the spinescent ones of *P. austriaca* remain green for four or five years. But the strongest of all points is, that on dissection of an old fascicle, it will be found to have a distinct connexion with the woody system of the tree, and that these minute woody axillæ under each fascicle increase in size with the age of the sheath. With a very little encouragement these woody axillæ can be induced to elongate and become real branchlets. If the leading shoot, for instance, of a pine be tipped in May just after pushing, bulblets will form in every fascicle below, and the next season the bulblets will produce weak branchlets, although this might be said of true leaves, which are supposed to bear an embryo shoot in the axil of every one. So much stress need not be put on this fact, as the others are sufficient; it is introduced, and its weak nature commented on, as it furnishes the chief point in Dr. Dickson's argument for *Sciadopitys*, which amounts to little more than that the apparently single phyllon is really a double one—a two-leaved fascicle united by a transformed sheath through its whole length. Carrière has since pushed Dr. Dickson's observations further by noting, in the 'Revue Horticole,' really bifid leaves, with little verticils in the axils (see reference in 'Gardeners' Chronicle,' May 2, 1868)—an observation which I confirm by a specimen exhibited herewith; yet, as I have said, it is by itself not wholly free from the objection that it may be but a modified form of regular bud-growth; but, together with my other observations, I think they do serve to confirm the point of these so-called leaves being but phyllodea.

In conclusion, I will restate the main points of this paper:—

The true leaves of Coniferæ are usually adnate with the branches.

Adnation is in proportion to vigour in the genus, species, or in the individuals of the same species or branches of the same individual.

Many so-called distinct species of Coniferæ are the same, but in various states of adnation.—*From the forthcoming volume of the Proceedings of the American Association for the Advancement of Science.* (Communicated by the Author.)

Mechanical Reproduction of the Flight of Insects. By M. Marey.

The author has already shown that by gilding the tips of the fore wings of a hymenopterous insect and allowing it to fly in the sun, the point of each wing is found to describe a figure of 8, indicating that in the course of one elevation and descent the wing moves twice forward and twice backward. To ascertain how this movement is produced, the author took a small glass rod blackened with smoke, and by presenting it to the wing in different parts of its passage, he found that the soot was rubbed sometimes on the upper and sometimes on the lower surface, according as the rod was held below or above the course of the wing forwards or backwards. From